Sat-Arch./Flat-Sat Telecon Participants

NASA/GSFC √ **Jim Rash** **Rick Schnurr** √ **Dave Israel** **Glenn Rakow**	**Computer Sciences Corp** √ **Keith Hogie** √ **Ron Parise** √ **Ed Criscuolo** **Tracy Dorsey** √ **Phil Meyers**	**Spectrum Astro** √ **Paul Schmidt** **Jennifer Lazbin**
Ball Aerospace **Randy Rose**	**Sanders (LM)** **Dave Maron** **Carl Beckmann** **Hamilton Stewart**	**Johns Hopkins Univ. / APL** **Paul Grunberger**
Universal Space Network √ **Jay Heberle**	**NM State University** √ **Steve Horan**	

√ Participated in 6/10/99 telecon

Satellite Backplane Discussion

Brief discussion on preferences for satellite backplanes

GSFC, Ball, Spectrum, Sanders - all gave positive response on 3U or 6U Compact PCI

Unless there is any other input, all plans for devices plugging into the FlatSat backplanes should be focused on using 3U or 6U Compact PCI

One alternative discussed by JHU/APL is P1394 backplane version

Some primary devices of interest are

- Processors
- Network Interface cards (e.g. Ethernet, ATM, Firewire (P1394), P1355)

Satellite LAN Options

- Current activities focused on discussing options and collecting information on what could be implemented in FPGAs or ASICs
- Ethernet (10/100/1000)
  - Jennifer (Spectrum) contacted Sierra Research for 10/100 IP for Ethernet
  - needs a digital controller and an analog/digital physical interface chips
  - controller 65K gates , phy 2.5mm^2
- P1355
  - 5/20/99 Glenn (GSFC) described technical details of P1355
    - Variable length packets passing through switches using wormhole routing
    - Primarily a physical link mechanism for data communication
    - Can support various upper layer data structures (e.g. ATM, IP packets, disk sectors,)
    - High rate, 100s of Mbps

Satellite LAN Options (cont.)

- P1394 (Firewire)
  - 5/27/99 Paul (JHU/APL) presented P1394 (Firewire) info
    - 2 versions - cable and backplane
    - JPL working with cable version in X2000 activities
    - APL focusing on backplane version with Contour due to lower power, easier arbitration, looking into bridge/repeaters to extend 4.5 meter length
    - Avoids hogs since everyone must wait after xmit to give others a chance
  - Rick Schnurr - LM Manassas makes a rad hardened 1394 backplane chipset
  - Need to look into support for Internet Protocol (IP) over 1394, some activity but need to see who supports it (Cisco router with 1394 ???)

Satellite LAN Options (cont.)

- Myrinet
  - Sanders investigating, also used by DARPA/AFRL for network computing in space project
  - 6/03/99 Sanders provided more info on Myrinet
    - Full-duplex , byte-wide, 160 Mbytes per second (yes bytes not bits)
    - Physical - backplane, 10 foot ribbon, or fiber extension - multimode 550 m, single mode 10 Km
    - Circuit switching somewhat similar to 1355, very minimal buffers in switch fabric, control messages sent back for stop/go collision/flow control
    - Dynamic circuit setup or static tables
    - Header type byte to identify contents of packet
    - Maximum packet of 4 MB, size is function of timeout (25 ms.)
    - Lots more info at http://www.myri.com/ look under Research
    - Existing products too
    - No mention of any Rad hard versions for space, but interest by DARPA
- ATM ???
- QHSS - Quad HS Serial, 5 Mbps, rad hard, LM proprietary (6/10/99)

Satellite Operating Systems

- Brief discussion of real-time operating systems for satellites
- JHU/APL - VxWorks
- Sanders - VxWorks, LynxOS
- Spectrum - VxWorks
- USN - VxWorks
- Ball - VxWorks (6/03/99)
- General indications of lots of groups using VxWorks but some concerns that there may be other, better options out there.
- LynxOS seems to have better protected memory capabilities.
- Linux is of interest but not sure it’s quite ready yet
- VRTX passed a very strict FAA “test every line of code” certification
- 6/10/99 more discussion of need for access to all memory but different opinions on whether that is a kernel or application funtion

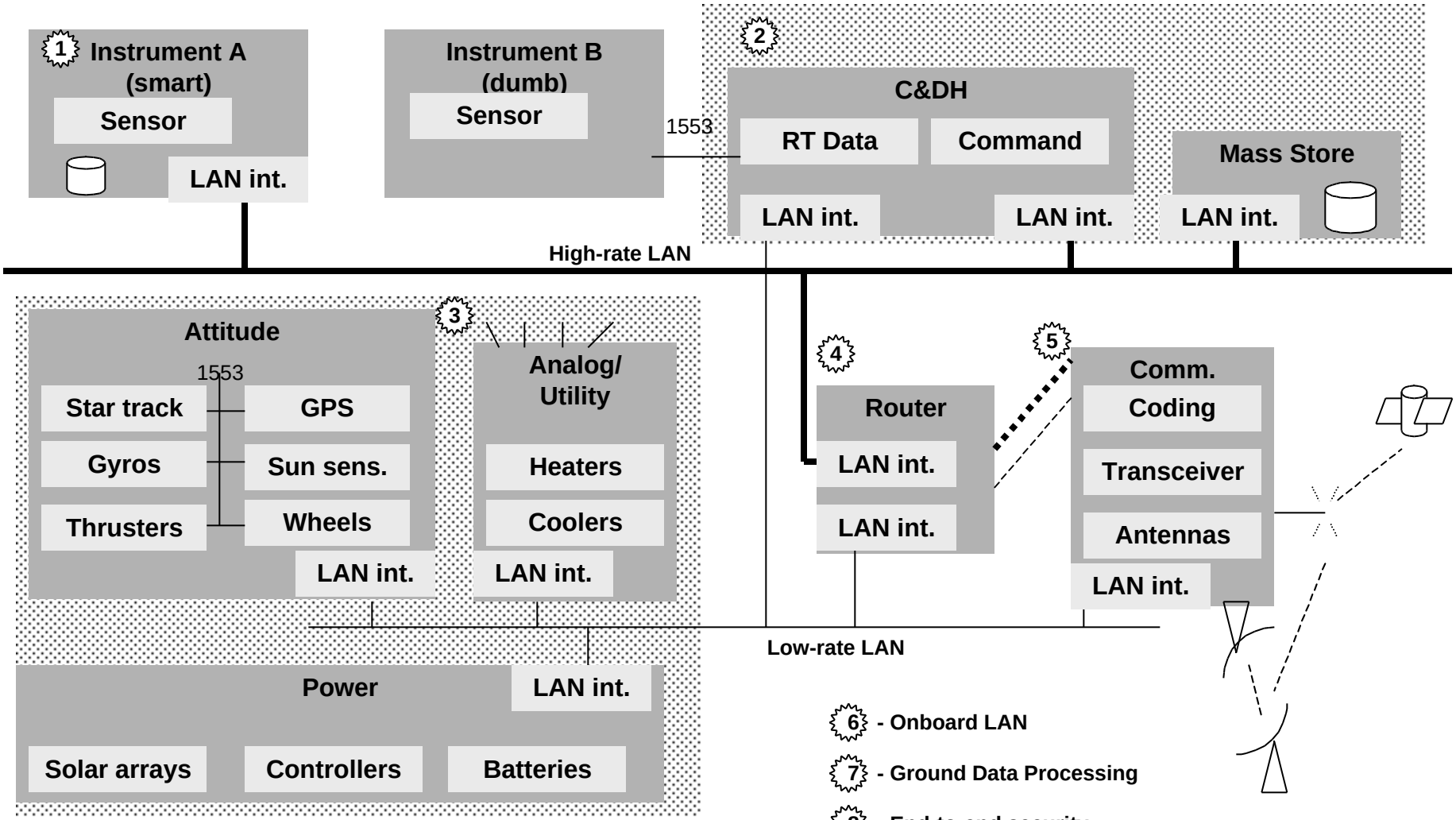
RF/Comm Subsystem Discussion

- Goal is to try to identify large market of commercially available ground RF equipment/standards and see if they are “good enough” to support future science satellites.
- Intelsat standards (e.g. Reed/Solomon, convolutional coding, etc.) are supported by many manufacturers
  - What is the real difference between Intelsat and CCSDS Reed/Solomon
- Other options in Direct Video Broadcast which uses Reed/Solomon around its MPEG video, lots of set-top boxes and cheap receivers
- Need to look at ATM Forum activities for ATM over RF links
- Other key interoperability issues
  - Below coding - what about common signaling frequencies
  - Next step up from coding - What is the proper framing to use to provide a common signaling channel among all satellites
- Need to get industry involved here - Motorola, ???
- 6/10/99 - Higher uplink rates (e.g. 128, 256, 300 Kbps) in S-band are not a big problem, just need to say “do it”
- Some talk about finding real hardware, GRC activities in the Sicom chip

Potential Flight Opportunities

- Everyone asked to think about opportunities for flying equipment to demonstrate IP to satellite issues
- Paul - Air Force MightSat - looks very interesting - for more info see - www.spectrumastro.com/Programs/MightySat.asp
- Steve Horan - NM State - Air Force nanosats in next 2 years - another very interesting option, short duration, lots of prototype testing
  - works with balloon scientist who build instruments with IP interface
- Frank Bauer, Dave Weidow - Orion - GPS experiment - Stanford
- Hitchhiker
- Spartan
- NASA experimental research planes - Wallops - TILT on a plane
- Shuttle - Boeing phased array antenna
- Balloon test flights
- GAS can
- Redeye/NEXUS may be good mission (2003)
- Space Station express pallette

Flat Sat Subsystems



Satellite LAN options : 10, 100, 1000 Mbps Ethernet,
ATM, FDDI, 1355, FODB

Science Platform Subsystem Descriptions

The subsystems were broken out to allow independent discussions on a common satellite architecture. The following descriptions contain some of the thoughts on functionality of each subsystem.

1. "Smart" Instrument - Instruments that have their own IP address, internal autonomy, possibly internal mass storage, PI may interact directly from ground to the instrument

2. C&DH system - Central point for monitoring other subsystems, interface to older instruments with 1553 interfaces, repository for stored command handling, interfaces to all onboard LANs to monitor everything, possibly interface with Mass Storage or else Mass Store is intelligent network connected device supporting FTP, NFS

3. Housekeeping subsystems - Standard satellite components that may not change too much from present. Add some LAN interfaces to provide access to these subsystems but amount of intelligence in basic subsystems may be minimal.

4. Onboard router - Processor with LAN and serial interfaces to pass traffic between communication subsystem and onboard LANs. Also supports functions such as network packet framing, traffic prioritization, security firewall, mobile IP.

5. Communication subsystem - Communication subsystems provides bitstream interface to onboard router and performs desired bitstream coding (convolutional, Viterbi, Reed/Solomon, etc). , transceiver functions, and antenna management. LAN interface for monitor and control functions. Directional and omni antennas, different rates, possibly intersatellite links.

6. Onboard LAN - Peer-to-peer LAN that does not require C&DH to constantly sample each node. Possibly multiple LANs for traffic segregation or redundancy.

7. Ground Data Processing - Functions performed on the ground to capture, process and forward science products in reliable and automated fashions.

8. End-to-end security - Security solutions to be implemented on the various systems involved in the end-to-end data flow. Techniques such as Virtual Private Networks, IPsec, authentication, encryption, key management

9. Advanced mission operations - Any thoughts on new operation modes enabled and futuristic ideas on new types of science that can be performed (e.g. constellations of satellites, missions interacting with each other, etc.)